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Creating a New Product Paradigm between Media Space and Physical Space

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Abstract

There is a growing need to create new types of products, documents and environments that more seamlessly integrate electronic knowledge resources in media space into the space of human experience. With new embedded technologies and networking technologies, the two spaces, once separate can be bridged to create an environment that weaves coherent relations between physical objects, media entities, and human experience in our activities. The integration of physical space and media space opens new design spaces and raises new issues. In this paper, three emerging issues that have fundamental impacts on the field of design are discussed, and some related design cases are introduced. This paper focuses on three emerging issues in design: 1) new product paradigms emerging between physical space and media space, 2) incorporation of computing and networking functions into physical products to enable seamless infrastructures for continuing services and knowledge lifecycles, and 3) positioning users as strategic partners and resources in product and business development. In order to effectively respond to these issues, several research initiatives are in progress at the Institute of Design, IIT. The goals of these initiatives are to understand the nature of the new design space, develop conceptual frameworks of new design paradigms, and establish a coherent system of knowledge and design methods.

1 Introduction

Embedded technology enables physical products such as office equipment, stationery, home appliances, and architectural components to incorporate computing and networking functions. It enables the integration of physical objects with information infrastructures, and the augmentation of the physical environment with information and computing functions (Figures 1) (Lim & Kim, 1999, Lee, 2000, Itoh et. al., 1996). The physical world can be intensively interconnected, and provide new functionality across the boundaries of individual products to achieve new qualities of human experience (Sato, 2000). This new product paradigm generates new dimensions for design.

2 A New Product Paradigm: Designing between Physical and Media Spaces

When physical products acquire computing functions and connections to media entities and other products through the network, functions of those media and physical entities become accessible through the product that the user is directly interacting with. In such networked systems, some functions could reside anywhere in the system, could be composed of remotely distributed functions, or could simply reside within one entity. Products in this new category have properties of both physical entities and media entities. Because of its unprecedented qualities, achieving socially and culturally coherent qualities will become major issues in design and design research.

2.1 Users' Viewpoints and Aspect Models of physical/media systems

The user understands the object from multiple viewpoints. Each viewpoint generates aspect models that capture different characteristics reflecting users' concern and intention as shown in Figure 2 (Sato, 1993). Some aspect models represent the physical nature of the system, some aspects represent the intrinsic nature of media entities, and some aspects are common to both physical and media entities as indicated in Figure 3. The user also attempts to create a coherent overall understanding of the object by articulating aspect models

a) Stella: A Physical Interaction System for Museum Learning

b) MusiCleaner: with Floor Cleaning and Learning Functions

c) A Puppet Driven Communication and Collaboration System for Children

Figure 1 Prototypes of Physical Products Integrated with Media Systems

from both spaces. Although the user usually knows which aspects belong to which space, intensive engagements with particular aspects sometimes blur the boundary between physical and media spaces. Attempts to switch between different viewpoints can be used to create interesting perceptual and intellectual experiences for the user. In the development of a system composed of both physical and media entities, the multi-aspect model works as a conceptual framework and communication platform for human-centered design methodologies to incorporate users' views in the system design as well as the multi-disciplinary viewpoints of the development team (Sato & Lim, 2000).

2.2 How can physical products be extended into the media world?

The integration of individual artifacts into a larger system through the media space allows flexibility of function allocation over the system because of seamless connectivity across the system as shown in Figure 4. A function allocated to an artifact could be re-allocated or duplicated to another part of the system, or decomposed into lower level functions and distributed over multiple entities. Figure 5 schematically shows different distribution patterns of functional units over the system to compose higher level functions 1, 2 and 3. Physical system A performs all three functions in physical entity b with the user interface represented by a circle. Through the connection to the media space, the boundary of the system A extends to B, incorporating media entity c and d to enhance function 2 and 3. System C incorporates physical entity a to enhance function 1. System D includes media entity f. System E incorporates all entities in the physical and media spaces. In more advanced system architecture, allocation of functions can be dynamically determined by searching appropriate subfunctions to compose a requested function by the user, and software modules can be transported over the network for optimizing performance or upgrading currently deployed modules.

2.3 Exploration in the New Design Space

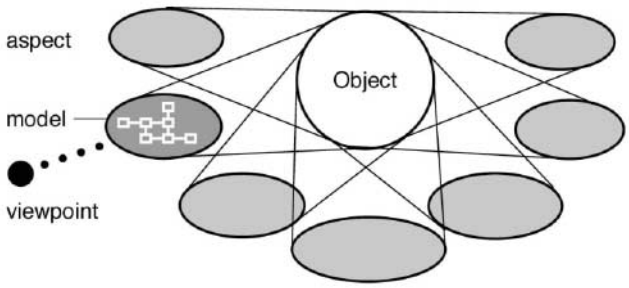


Figure 2 Multi-Aspect Models and Viewpoints

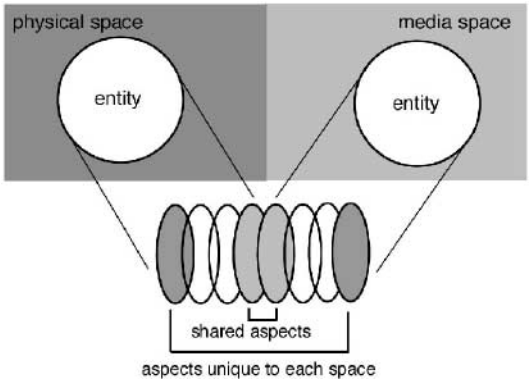


Figure 3 Aspect Models of Artifacts in Physical and Media Spaces

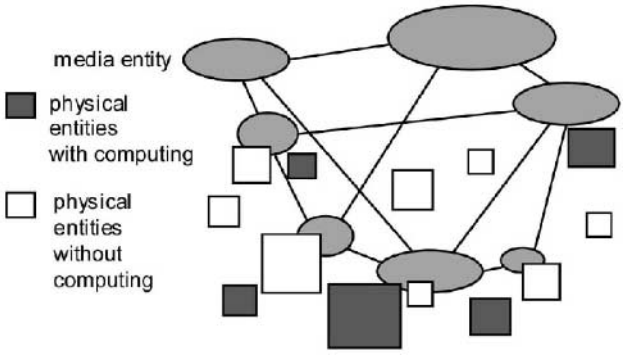


Figure 4 A Interconnected System with Physical and Media Entities

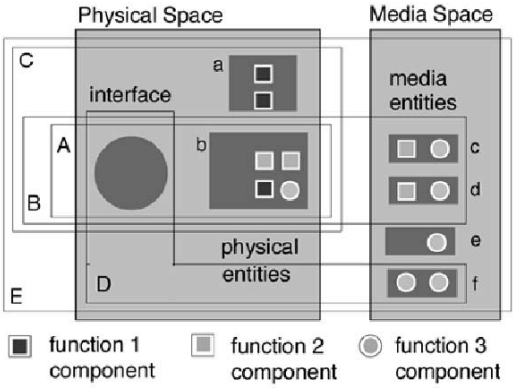


Figure 5 Product Architecture for Flexible and Dynamic Function Allocation

As the system gains more flexibility and adaptability, it becomes more difficult for the user to develop consistent mental models that can accommodate dynamically changing system configurations and boundaries. The system image presented to the user therefore needs to not only reflect these qualities but also to provide interpretive mechanisms to support users' understanding. Effective interaction methods for this type of system architecture need to be explored and studied.

3 Human-Centered Design as a Platform for Product Innovation

In conventional manufacturing industries, the manufacturer's contact with the customer takes place indirectly at the point of purchase through dealers, except for complex industrial systems that require continuing maintenance by the manufacturer. This typical pattern of manufacturer-customer relation has been changed by several factors including the popularization of Internet, the growing complexity of product functions, fast changing technologies, competitive markets, and the shift of users' values from artifact-based values to service-based values. Mobile phones are a good example of a service-based product that functions as an access gate to a larger scale service infrastructure. This opens multiple channels of manufacturer-customer relations through out the product lifecycle as indicated in Figure 6.

3.1 Knowledge Lifecycle: Knowledge of Use and Knowledge of Design

In the conventional model of product development, knowledge of design is generated in the development process and embedded in the product. Users are typically considered as a field of marketing research data or as subjects of studies without recognizing the knowledge they produce. The knowledge lifecycle model in figure 6 introduces the concept of "knowledge of use". The use process is a knowledge generating activity that contributes to the formation of the lifecycle (Teeravarunyou & Sato, 2001). In the use process, users generate knowledge by interpreting the information

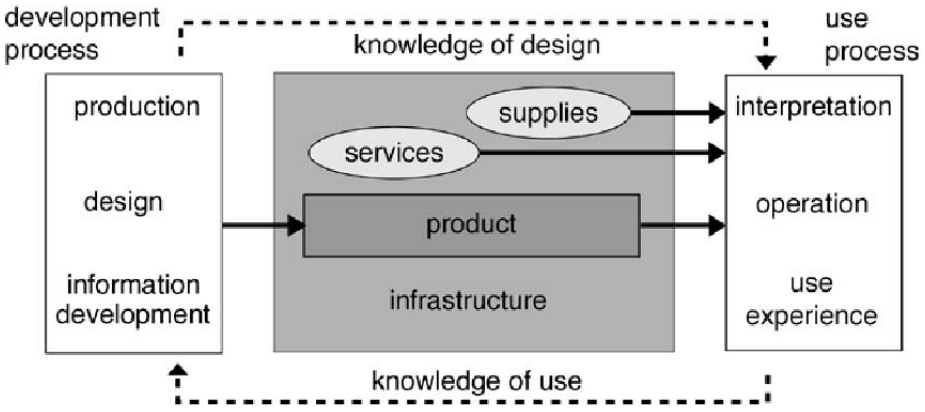


Figure 6 Knowledge Lifecycle Incorporated into Product Development Lifecycles

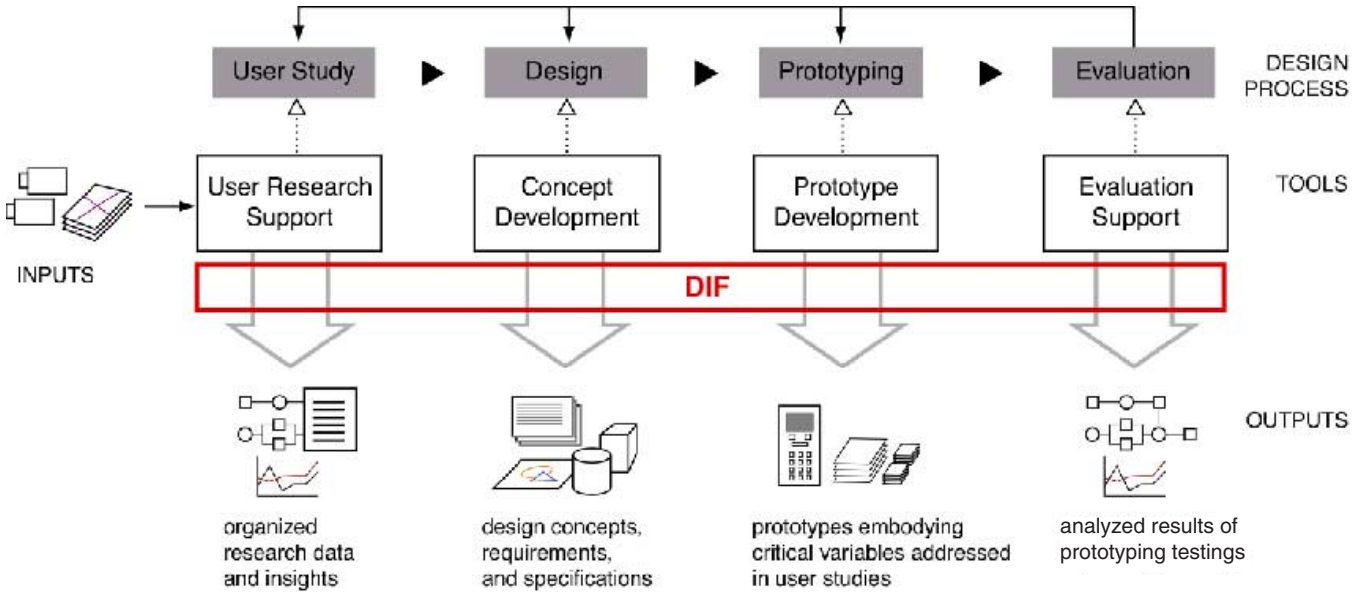


Figure 7 Design Information Framework as an Infrastructure for Design Processes

embedded in the product, applying the product to a specific situation, or reflecting on the experience of use. In the new product paradigm, services and supplies become major channels of manufacture-user relations. It allows manufactures and service providers to have direct interaction with their customers through mechanisms for monitoring use conditions and acquiring user-generated knowledge, as well as providing continuing services, supplies, and upgrading.

3.2 Users as Partners and Strategic Resources

In the historical development of industrial organizations, different factors such as labor, materials, finance, technology, management information and most recently information technologies were recognized as strategic resources. When electronic media establishes a network of continuing communication between manufactures, service providers, and customers, it could become a platform for new business, social, and technological development. While technological competence of industries continues to grow, the complexity of the market and people's life patterns has dramatically increased. Ability to understand users and use contexts becomes a critical factor for building competitive advantage. The knowledge lifecycle between the manufacturer, users, and the service provider supplies accurate information about what users want and how they operate with products and services, while users can receive continuing upgrades and refined services. Companies that build effective user networks, knowledge lifecycles, and close partnerships with users can gain competitive advantages in understanding users needs, predicting social changes and making innovations best supported by user communities.

4 Design Research and Development: exploration into the new space of design

The new product paradigm requires a re-framing of our experiences accumulated in designing physical products and media products, and the development of conceptual foundations and design methodologies from the viewpoint of human-centered design. In this section, emerging design research issues will be explained by introducing some of research initiatives at the Institute of Design, IIT. In order to effectively respond to the emerging issues from human-centered viewpoints, five research focuses were identified: 1) users and contexts, 2) media and language of communication, 3) interactive systems, 4) strategic design planning, and 5) design systems. While continuing to enhance these areas, specific research projects with specific interest are set in collaboration with external partners and sponsors. The following are examples of design research initiatives currently in progress.

4.1 Tangible Knowledge

Knowledge management typically seeks to improve the

collection, organization and dissemination of information across an organization. The Tangible Knowledge initiative intends to develop methods and tools that help companies develop products and systems that effectively form seamlessly integrated environments for knowledge intensive work. The current research focus includes three projects: the development of a multi-aspect design information framework capable of capturing culturally-situated interactive behavior in knowledge intensive work; methods of using value structures to link user observation and early prototyping; and the development of a system of software and physical environments for decision-making activities by cross-disciplinary teams.

4.2 Multi-Aspect Design Information Framework

Understanding and designing a complex product, particularly an interactive system with physical and media entities involves many different viewpoints. Coordination between different disciplinary viewpoints and different phases of development is critical for achieving the quality of human-centered design. The Multi-Aspect Design Information Framework is a concept to accommodate different types of design information from different viewpoints and to build a unified design environment to support different activities in the design development lifecycle, from user studies to prototype evaluation as shown in Figure 7 (Sato & Lim, 2001).

4.3 Product Architecture, and Re-configurable Physical Interface

In order to incorporate diverse user needs, product and interaction architecture need to be explicitly defined as mechanisms for reflecting the structures of users' interactive behavior (Teeravarunyou & Sato, 2001). This project intends to develop a conceptual framework, product architecture, and explore its applications to re-configurable interface design that provide creative, exploratory, and self-learning mechanisms to accommodate individual users' preferences, multiplicity of use, and universality for extra-ordinary conditions. Application cases will be developed for different types of products and users. The working prototype models shown in Figure 8 are examples to explain the concept of re-configurable interfaces (Cho, et. al., 2001, Chen, et. al., 2001, Galvao, et. al., 2001).

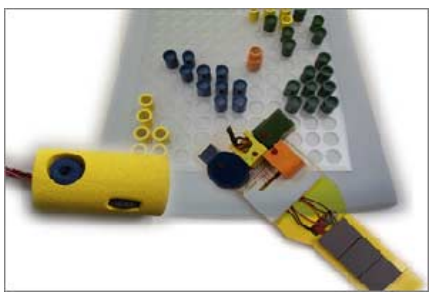
4.4 Global Companies in Local Markets

Cultural issues affect global business in three critical areas: 1) a company's own internal cultures, working in cross-cultural and inter-disciplinary teams, 2) producing products and services for users with diverse needs, values and habits, 3) managing brand in different cultures that will have different interpretations of a company's behavior and presence (Whitney 2001). Through case studies, the research will produce a framework of methods for understanding issues and helping the formation of strategies, a global network of specialists, and case stories that exemplify cultural significance in setting strategies for products, services, and communication for global operations.

4.5 Informal Learning

The Informal Learning initiative looks at strengthening the relationship between formal learning (school) and informal learning (urban resources like museums and parks). Building a bridge to integrate the many ways to learn will involve a conceptual connection between media and physical space to

a) Electronic Story Book Book



b) Nature Exploration and Mapping Kit

c) A Game and Communication Kit for Children with Disadvantages

Figure 8 Example Products with Re-configurable Interfaces

reveal hidden resources and make explicit learning objectives for planning. This initiative focuses on the regional resources with the purpose of integrating children meaningfully into its life.

5 Conclusion

This paper explained the emerging forces that are having a fundamental impact on the evolution of design practice. In particular, the emergence of the new product paradigm bridging the physical and media spaces has added new dimensions to the field of design. The complexity of the design problems does not yet allow empirical approaches in this little-explored domain. It requires design to evolve from an experience-based profession to a knowledge-based profession by constructing its own system of knowledge that frames human-centered design concepts and communicates with other collaborating disciplines (Sato, 2000, Poggenpohl, 2000, Sato & Whitney, 2001). The recent myth of a "faster, cheaper and better" way of developing products becomes possible only by consistent efforts to establish systematic foundations and readiness for product development by investing in human resources, organization, methods, tools, and culture (Owen, 1992).

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